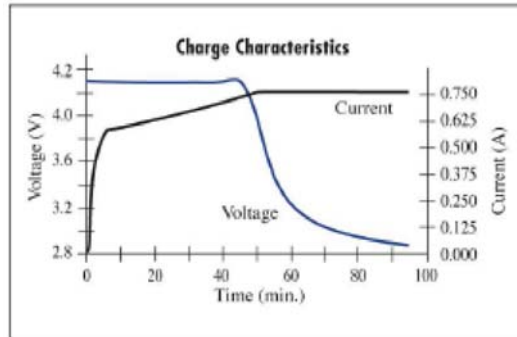


Lithium-Ion & Lithium Polymer Cells and Batteries

Safety Precautions

A. CHARGING THE BATTERY

To charge lithium-ion and lithium polymer batteries, please use the "CC/CV" (constant current/constant voltage) method illustrated below.



- 1) **Charge Voltage:** Limit the maximum charge voltage to 4.2V times the number of cells connected in series. Ultralife recommends a maximum of 4 cells in a series string.
- 2) **Charge Current:** Ultralife recommends a charging current of C/5 for lithium-ion and lithium polymer cells and battery packs. If the voltage per cell is 2.9V or less, charge using a charge current of 0.1 C or less. (Contact Ultralife for information regarding pulse charging.)
- 3) **Charge Temperature:** Do not charge lithium-ion or lithium polymer cells or packs at temperatures greater than 45°C or less than 0°C.
- 4) **Reverse Polarity Charging:** Verify the polarity of the battery before charging to ensure proper charging.
- 5) **Charge Control and Battery Pack Protect Electronics:** Use a constant voltage, constant current (CVCC) lithium-ion (Li+) battery charge controller. Charge controller manufacturers include: Benchmarq Electronics, Mitsumi Electric, Unitrode, National Semiconductor and Maxim.

A battery protection circuit to control overvoltage, undervoltage and current surges is required. The circuit must be applied to the battery pack or cell stack using ultrasonic or resistance welding. Backup protection can also be applied to the device being powered or to the charger. Protection circuit manufacturers include: Benchmarq Electronics, Mitsumi Electric, ational Semiconductor, Patco Electronics, Powersmart, and Seiko Instruments.

To ensure peak battery performance and maximum cycle life, the circuit must include:

Overcharge Protection:

- A maximum voltage threshold of 4.30V.
- If the maximum charging voltage is surpassed, the protection circuit interrupts or stops charging.

Overdischarge Protection:

- Voltage threshold of < 2.3V is NOT recommended.
- If the battery is discharged below the cutoff voltage, the protection circuit stops discharging.

Overcurrent Protection:

- If current exceeding the battery rating or recommendations flows during charging or discharging, the charge or discharge process stops.

Safety Precautions for Lithium-Ion and Lithium Polymer Cells and Batteries

B. DISCHARGING THE BATTERY

- 1) **Discharge Current:** Recommended discharge current is 1.0 CmA or less. Please consult Ultralife if you plan to discharge the battery with a current in excess of 1.0 CmA.
- 2) **Discharge Temperature:** Recommended discharge temperatures are between -20°C and +60°C. Please consult Ultralife if you plan to discharge the battery at temperatures less than -10°C.
- 3) **Discharge Termination Voltage:** Avoid discharging below 3.0V per cell. Overdischarge can damage the performance of the battery. Equip the unit with a mechanism to prevent overdischarge, especially in situations where the user may forget to turn equipment off.

C. EQUIPMENT DESIGN

- 1) **Installing Battery Packs in the Equipment:** To avoid damage to the battery pack, make sure the battery pack is positioned away from heat sources in the equipment or in the battery charger.
- 2) **Mechanisms to Prevent Dropping:** Be sure to use a battery pack locking mechanism to prevent the battery pack from being ejected if the equipment is dropped or receives a sudden impact.
- 3) **Preventing Short Circuits and Reversed Connections:** Use a terminal structure that makes it unlikely the terminals will be shorted by metallic objects such as rings, necklaces, clips, hairpins, etc. Structure the battery and the terminals to the battery in such a way that the battery pack cannot be put in backwards when installed in the charger or the equipment.
- 4) **Inclusion in Other Equipment:** If the battery is built into other equipment, use caution to strictly avoid designing airtight battery compartments.
- 5) **Terminal Materials in the External Equipment:** Use materials that are highly resistant to corrosion (such as nickel or nickel-coated copper). If contact resistance is an issue, we recommend you use contact plating (such as gold plating) on the terminals.

D. STORING THE BATTERY

Store battery at room temperature (19°C to 25°C), charged to about 30 – 50% of capacity or SOC (state of charge.) Ultralife recommends boost-charging battery once per year to prevent overdischarge.

E. USE OF THE BATTERY

See next section on "Safety Warnings for Lithium Ion and Lithium Polymer and Battery Packs."

F. OTHER

Chemical Reaction: Because batteries utilize a chemical reaction, battery performance will deteriorate over time even if stored for long periods of time without use. In addition, if the various usage conditions such as charge, discharge and ambient temperature, are not maintained within the specified ranges, the life expectancy of the battery may be shortened. If the battery cannot maintain a charge for long periods of time, even when it is charged correctly, this may indicate it is time to change the battery.

G. PLEASE NOTE

The performance and life expectancy of batteries depends heavily on how the batteries are used. In order to ensure safety, be sure to consult with Ultralife in advance regarding battery charging and discharging specifications and equipment structures when designing equipment that includes these batteries.

Safety WARNINGS for Lithium-Ion and Lithium Polymer Cells and Batteries

A. WHEN USING THE BATTERY

! WARNING !

- 1) Lithium-ion and lithium polymer cells and battery packs may get hot, explode or ignite and cause serious injury if exposed to abuse conditions. Be sure to follow the safety warnings listed below:
 - Do not place the battery in fire or heat the battery.
 - Do not install the battery backwards so the polarity is reversed.
 - Do not connect the positive terminal and negative terminal of the battery to each other with any metal object (such as wire).
 - Do not carry or store battery together with necklaces, hairpins or other metal objects.
 - Do not pierce the battery with nails, strike the battery with a hammer, step on the battery or otherwise subject it to strong impacts or shocks.
 - Do not solder directly onto the battery.
 - Do not expose battery to water or salt water, or allow the battery to get wet.
- 2) Do not disassemble or modify the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode or ignite.
 - The protection circuit module provided with battery packs is not to be used as a substitute for a shut-off switch.
- 3) Do not place the battery in or near fire, on stoves or other high temperature locations. Do not place the battery in direct sunlight, or use or store the battery inside cars in hot weather. Doing so may cause the battery to generate heat, explode or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy.

! WARNING !

- 4) If the device is to be used by small children, the caregiver should explain the contents of this document to the children and provide adequate supervision to ensure the device is being used appropriately.
- 5) When the battery is worn out, insulate the terminals with adhesive tape or similar materials before disposal.
- 6) Immediately discontinue use of the battery if, while using, charging or storing the battery, the battery emits an unusual smell, feels hot, changes color or shape, or appears abnormal in any other way. Contact Ultralife if any of these problems are observed.
- 7) Do not place the battery in microwave ovens, high-pressure containers or on induction cookware.
- 8) In the event the battery leaks and the fluid gets into one's eye, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated, the battery fluid could cause damage to the eye.

Safety WARNINGS for Lithium-Ion and Lithium Polymer Cells and Batteries

B. CHARGING PRECAUTIONS

! WARNING !

- 1) Be sure to follow the warnings listed below while charging the battery. Failure to do so may cause the battery to become hot, explode or ignite and cause serious injury.
 - When charging the battery, either use a specified battery charger or otherwise ensure the battery charging conditions specified by Ultralife are met.
 - Do not attach the battery to a power supply plug or directly to a car's cigarette lighter.
 - Do not place the battery in or near fire, or in direct sunlight. Heating the battery can damage the safety circuitry, which can cause additional heating, rupture or ignition of the battery.
- 2) Do not continue charging the battery if it does not recharge as specified on the product Technical Data Sheet.

The temperature range over which the battery can be charged is 0°C to 45°C. Charging the battery at temperatures outside this range may cause severe damage to the battery or reduce battery life expectancy.

C. WHEN DISCHARGING THE BATTERY

! WARNING !

Do not discharge the battery using any device except for the specified device. When the battery is used in devices other than the specified device, it may damage the battery or reduce its life expectancy. If the device causes an abnormal current to flow, it may cause the battery to become hot, explode or ignite and cause serious injury.

The temperature range over which the battery can be discharged is -20°C to 60°C. Use of the battery outside this temperature range may damage performance of the battery or may reduce its life expectancy.

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To ensure user safety, please contact Ultralife Corporation when designing a device for use with Ultralife lithium-ion batteries